Wet Scavenging and Replenishment of Aerosol in the Warm MBL

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Scavenging and replenishment of aerosol

Why?

Removal of aerosol:

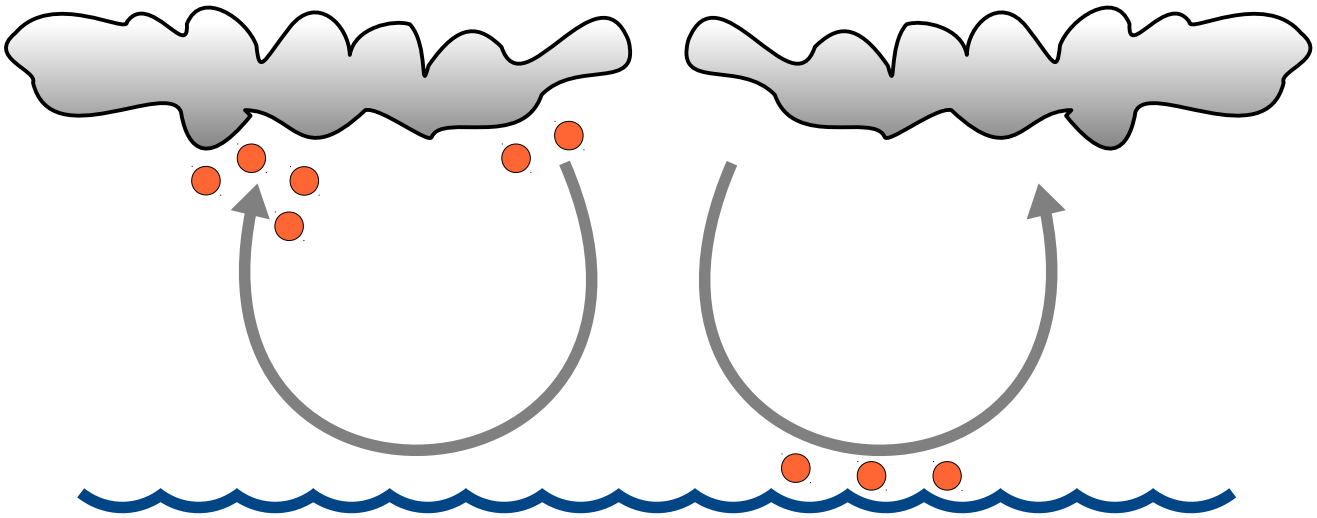
- Gives relevance to ...
- In some cases controls ...

} Aerosol replenishment processes

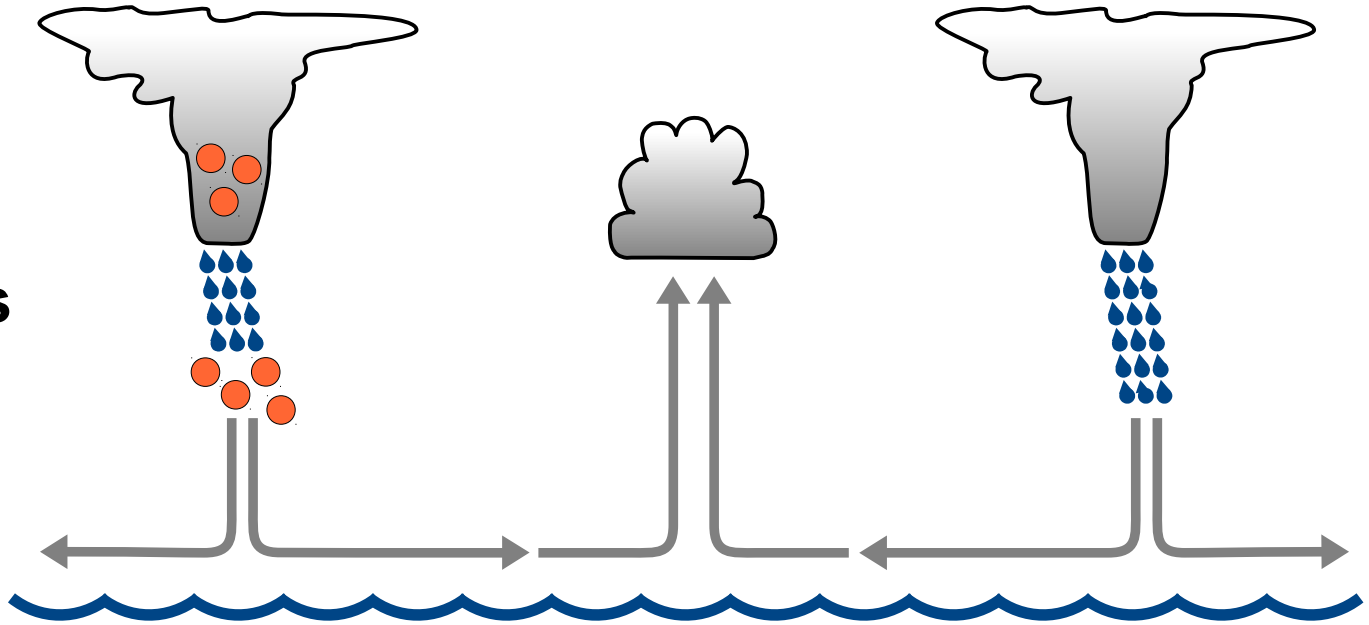
Replenished aerosol → cloud properties

➔Scavenging and replenishment of aerosol need to be well understood and represented in models

Aerosol loss

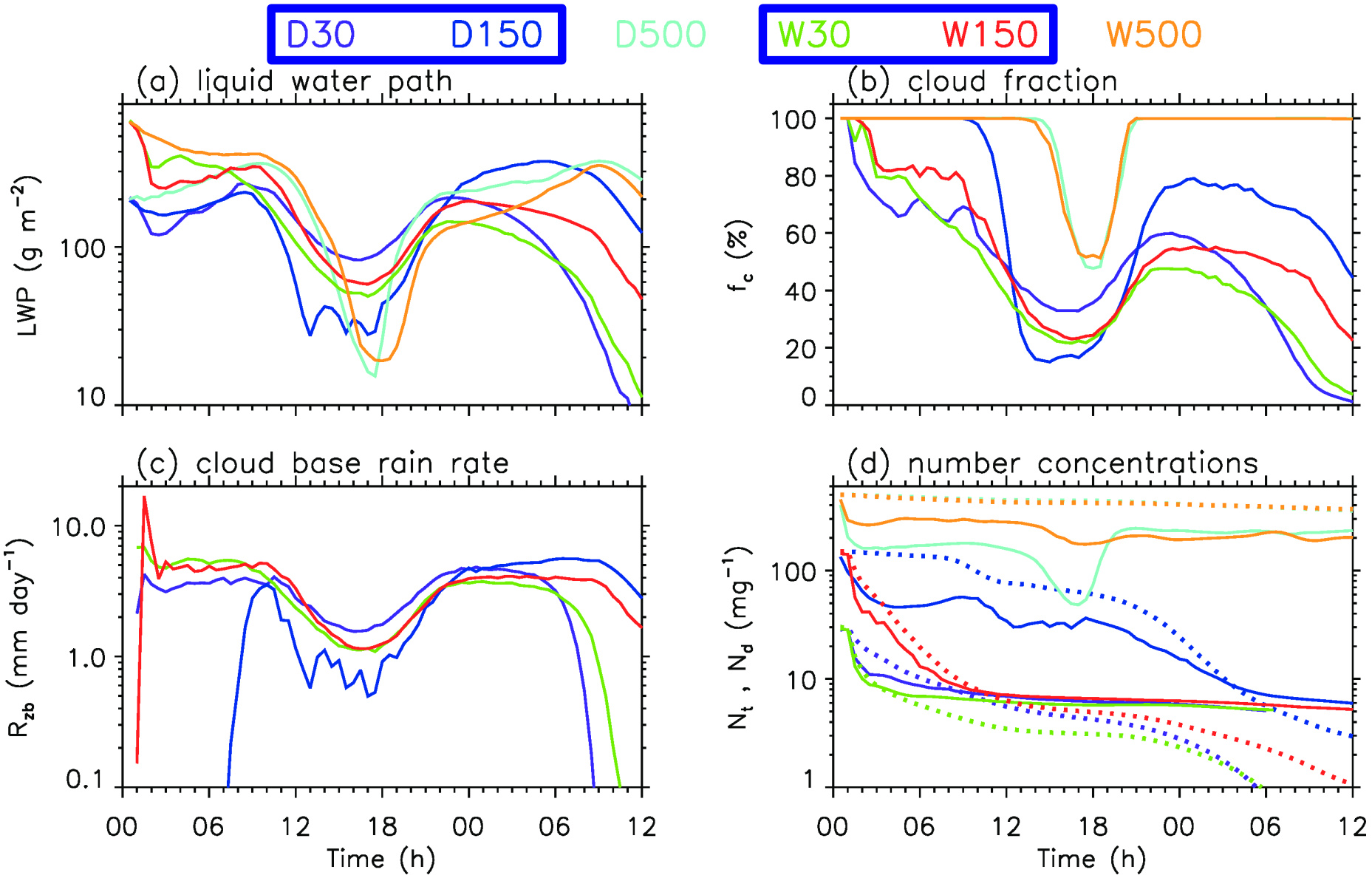


Closed cells



Open cells

No replenishment



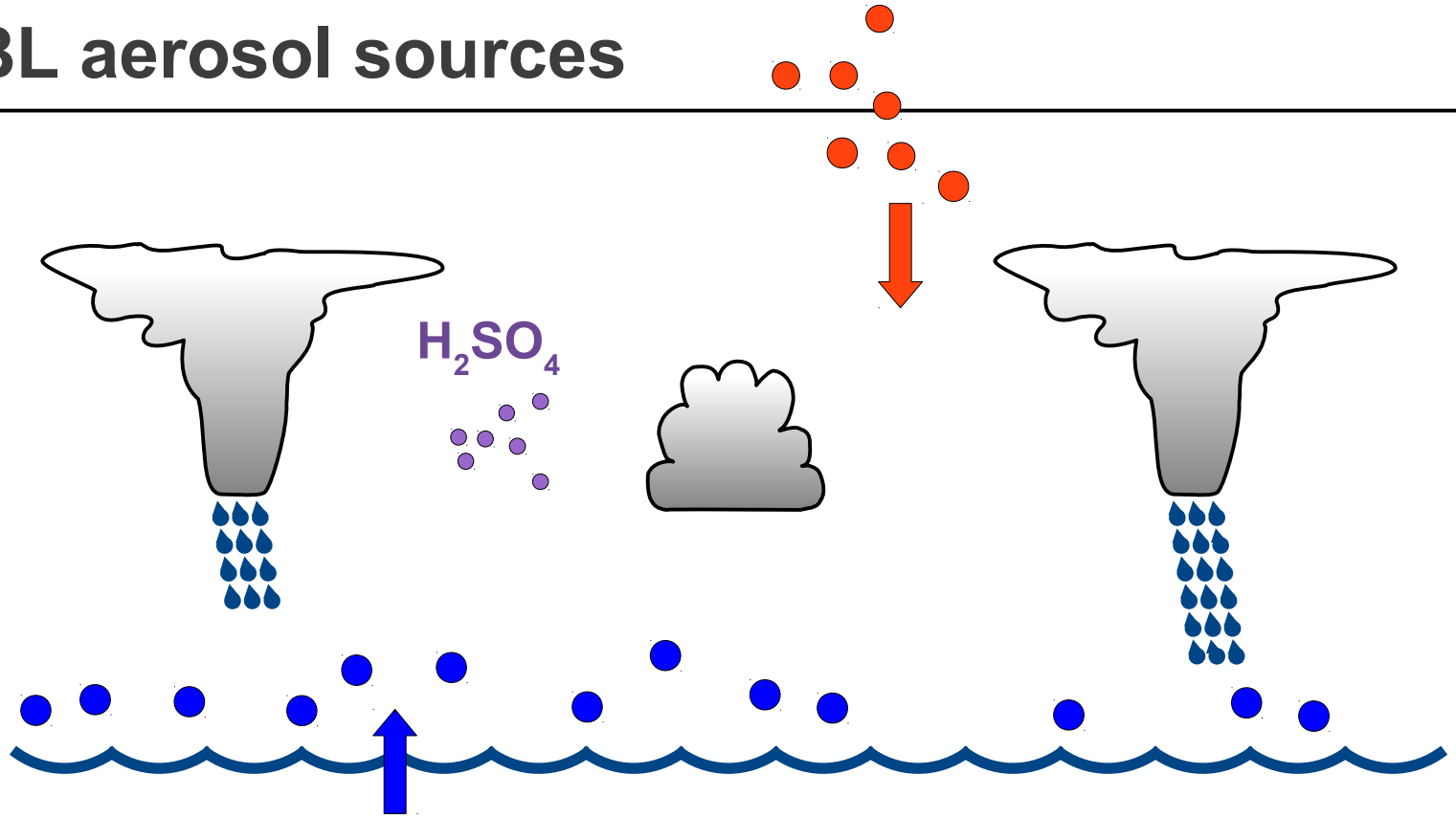
Wang et al., ACP 2010

No replenishment

- **Precipitation depletes aerosol → cloud formation is significantly suppressed within one day**
- **Aerosol replenishment rate of order 1 mg^{-1} h^{-1} is sufficient to maintain clouds**
- **Local / remote aerosol sources are necessary for open cells to last for days**

Wang et al., ACP 2010

MBL aerosol sources

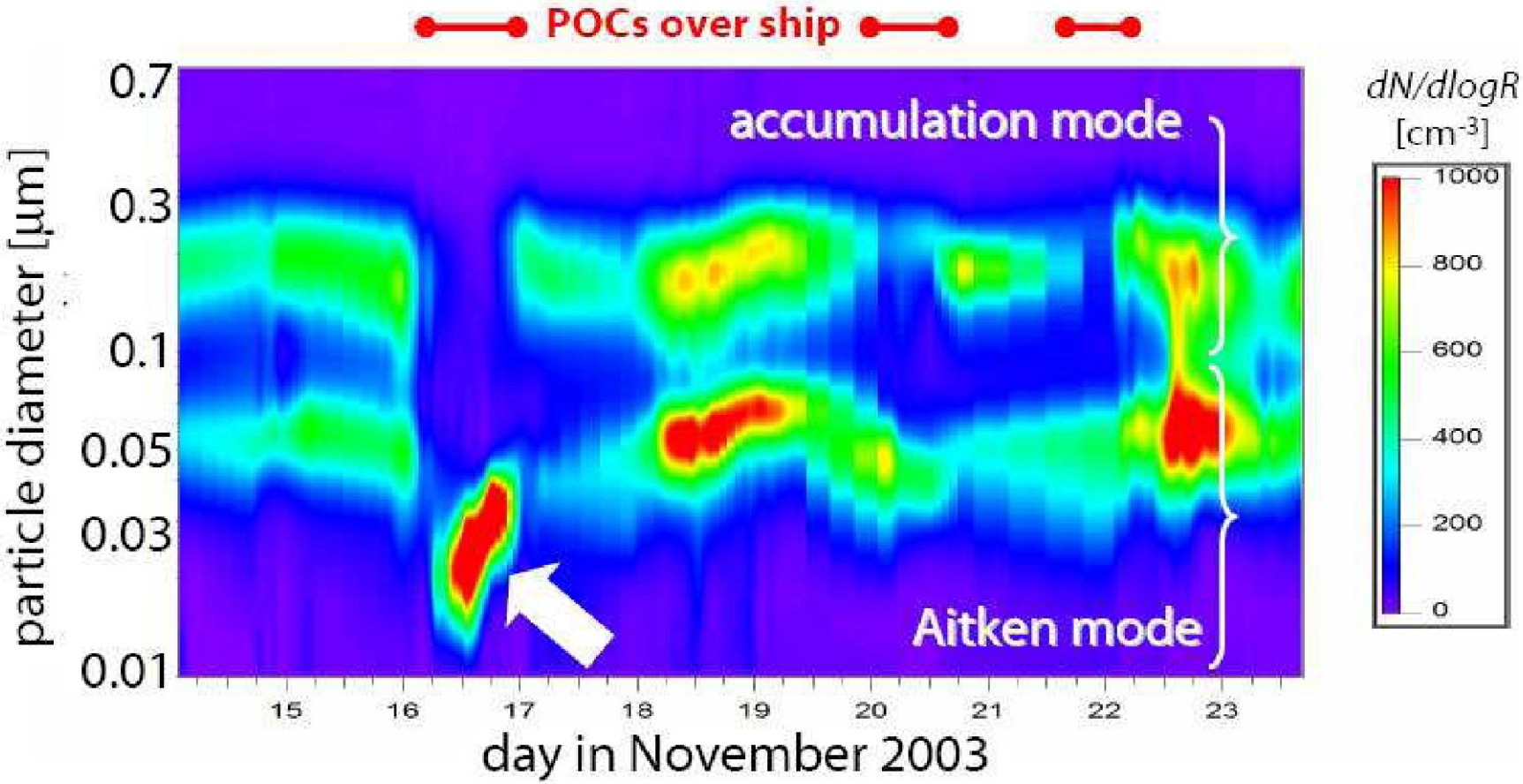


- **Sea spray**
- **Aerosol nucleation**
- **Entrainment from the FT:**
  - **“observed FT transport over thousands of kilometers indicates teleconnections between MBL CCN and sources of both natural and/or residual combustion origin” (Clarke et al., ACP 2013)**

Sea salt emissions

- **Sea spray can likely compensate CCN loss from wet scavenging, and maintain open cells:**
  - **VOCALS-REx RF06 ~ 2 cm^{-3} h^{-1} (Kazil et al., ACP. 2011)**
  - **> 1 μg^{-3} h^{-1} threshold (Wang et al., ACP 2010)**

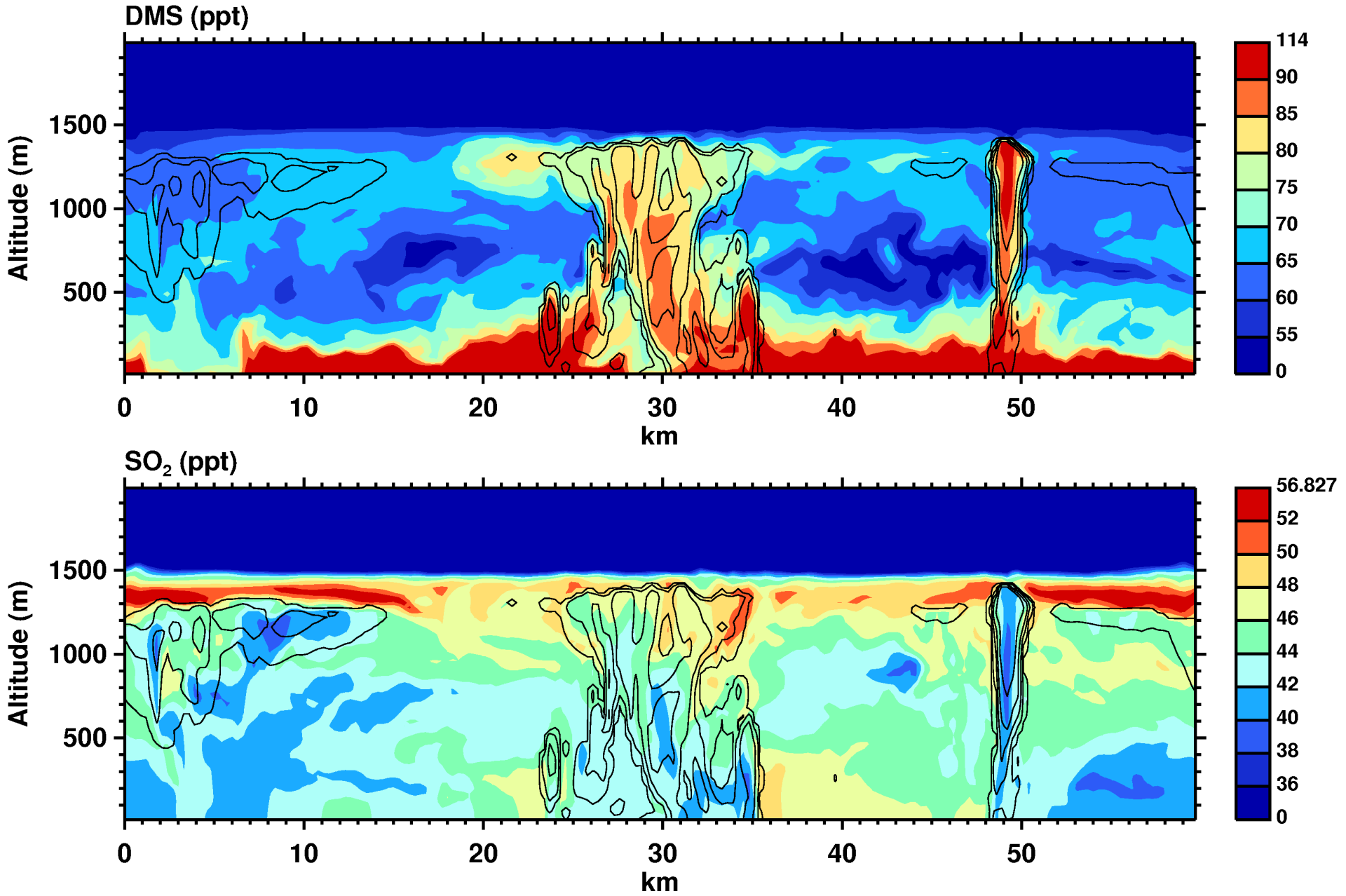
Aerosol nucleation



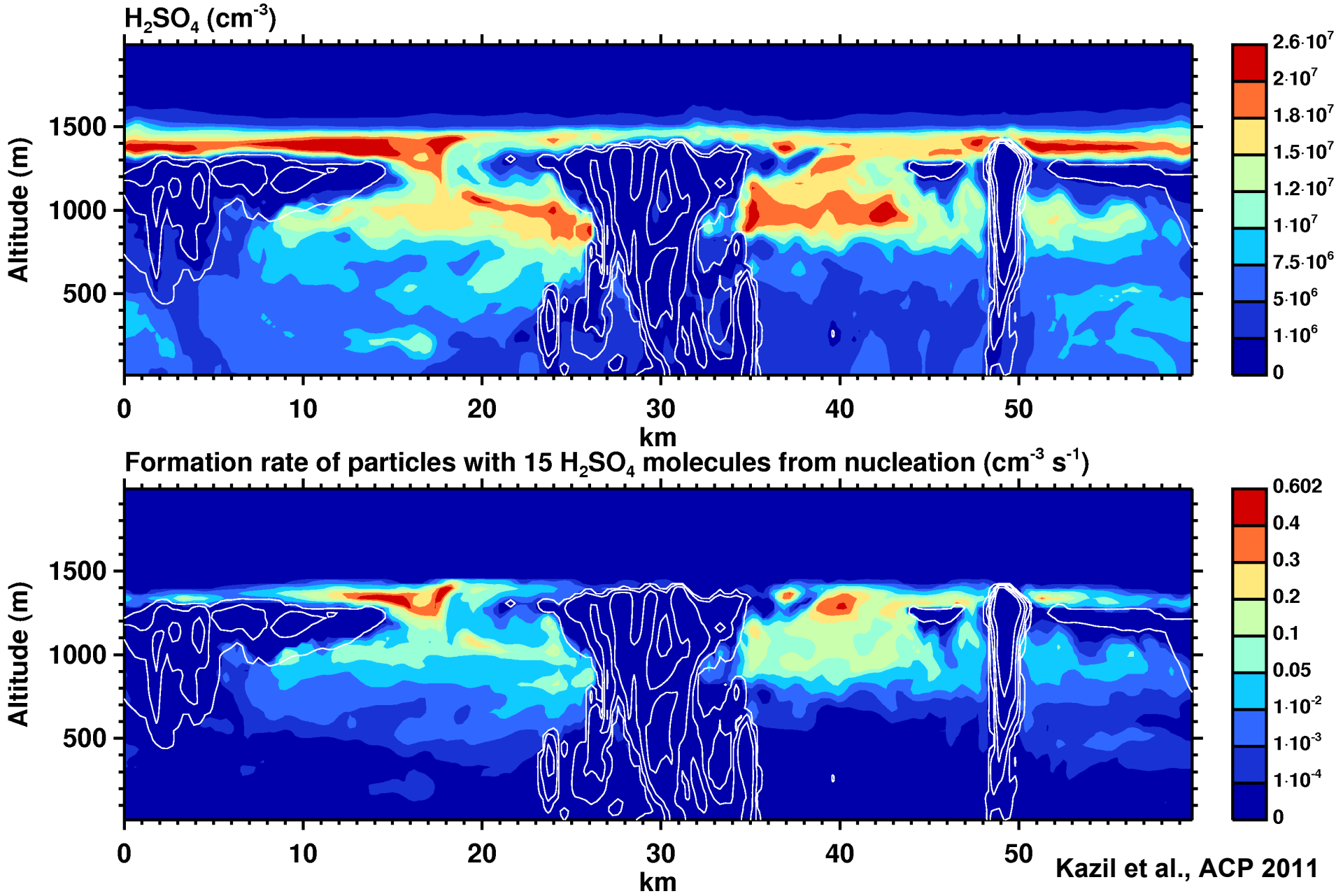
South-East Pacific, November 2003
(Tomlinson et al., JGR, 2007)

DMS → H_2SO_4 → nucleation → CCN

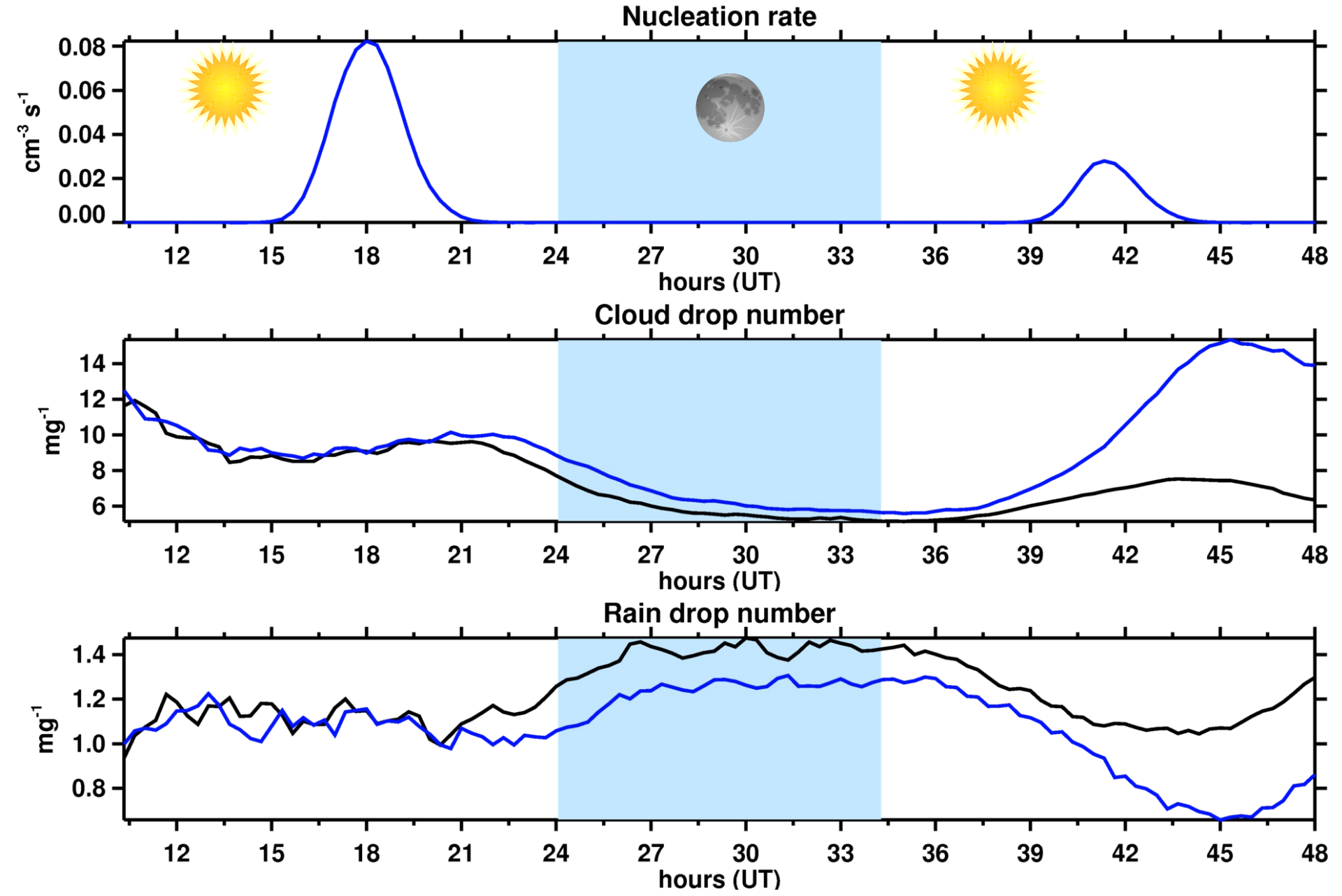
Aerosol nucleation (VOCALS, WRF/Chem)



Aerosol nucleation (VOCALS, WRF/Chem)

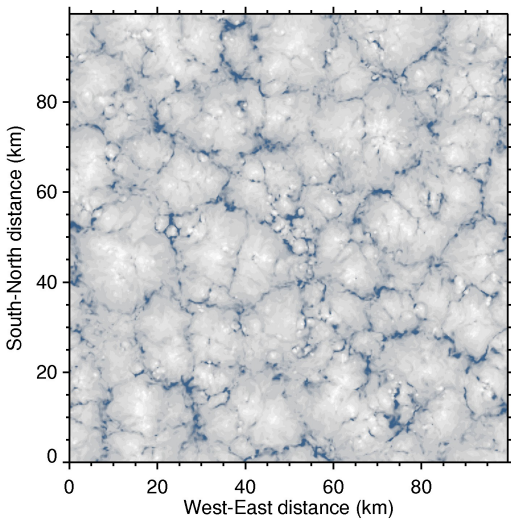


Nucleation and cloud properties (WRF/Chem)

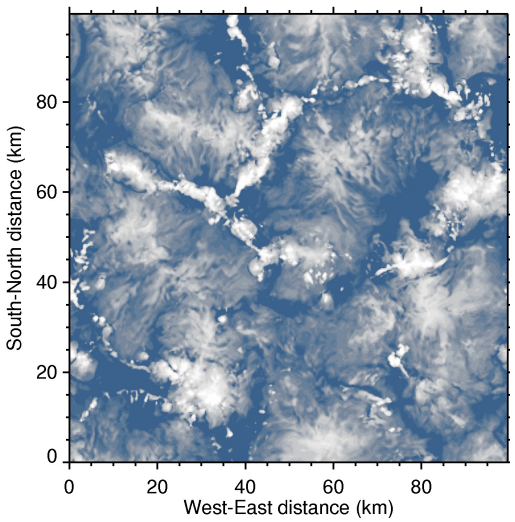


Entrainment of VOCALS pollution layer (WRF/Chem)

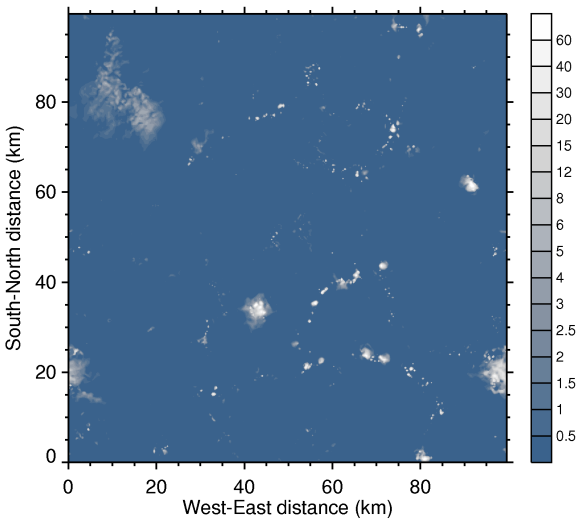
Clean



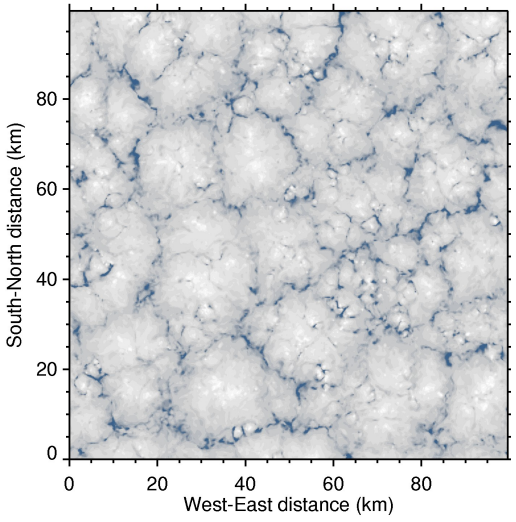
+ 14h



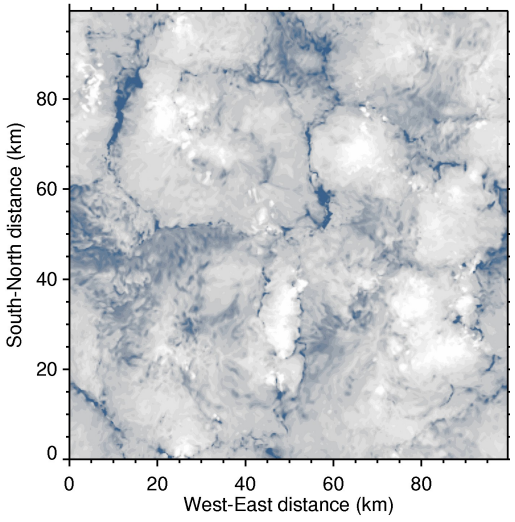
+ 21h



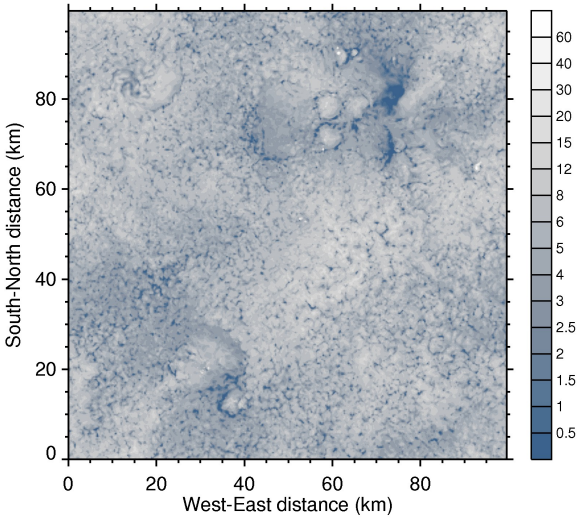
Pollution layer 60 m above inversion (1600 cm^{-3} in acc. mode, Clarke et al.)



+ 14h



+ 21h



Summary

- **Significant progress in modeling aerosol wet scavenging and replenishment in the warm MBL**

Challenges remain:

- **Trade-off between model domain size and resolution**
  - **➔Over-entrainment**
  - **➔Cloud response to pollution entrainment likely too strong**

- **(Over-) simplified aerosol schemes**
  - **➔ Very small aerosol particles likely grow too fast**
  - **➔ Cloud response to aerosol nucleation likely too strong**

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Wet Scavenging and Deposition: Quantification, Mechanistic Understanding, and Impacts

(Session A51G)

Armin Sorooshian – Jan Kazil